



Program Objective



**Demonstrate
a leap-ahead EM Gun armament
system that proves the maturity of
the technology for
future combat systems**

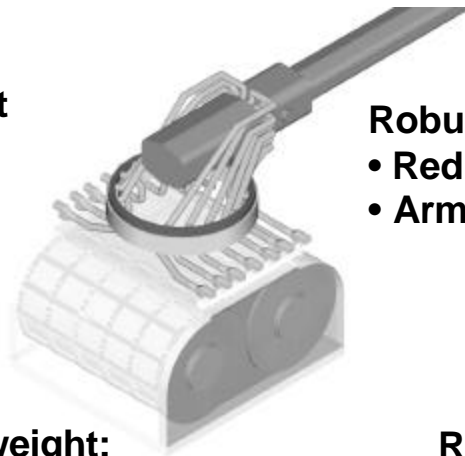
Army EM Gun Program Challenges



Pulsed Power

Increased energy density of rotating machines:

- Material strength
- Efficiency
- Thermal management



Launch Package

Robust lethality against future threats:

- Reduced parasitic mass
- Armature operation

Switching

Reduced volume and weight:

- Si & SiC development
- Efficient packaging
- Thermal management

Robust Launcher

Robust “fieldable” launcher:

- Wear life - material hardness
- Efficiency - energy recovery
- Thermal management - cooling

Current armament system is ~3 tons heavier than equivalent ETC system

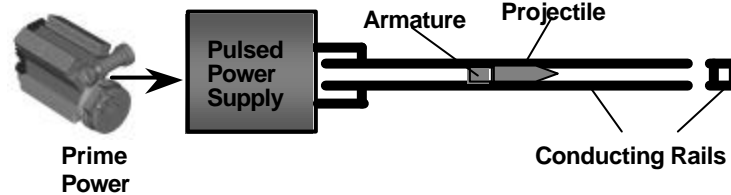
Significant Engineering Challenges - Physics Works

Army EM Gun Program Advantages



3 Orders of Magnitude Reduction
in Signature

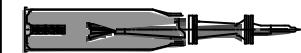
Stealth Launch



Replaces propellant (chemical energy)
with
mechanical energy & electrical energy



EM 90mm



ETC 120mm

1/3 the volume; 1/2 the weight

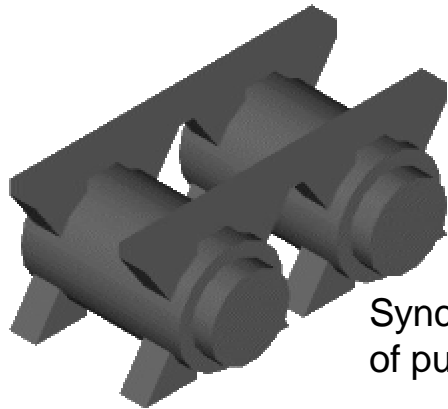
Improved Sustainment

- Improved lethality from adjustable velocity (including hypervelocity)
- Stealth launch
- Reduced logistics - eliminate chemical propellant; smaller weight/volume rounds
- Improved survivability - eliminate chemical propellants
- Synergism with system: electric protection, electric propulsion, electric weapon
- Shorter time of flight - accuracy
- Lethal from muzzle to extended ranges

A lethal armament for future combat systems

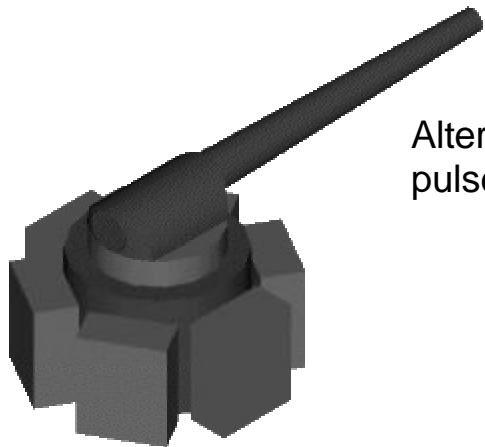
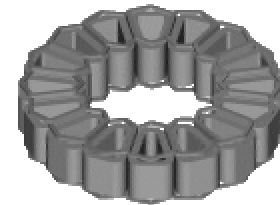
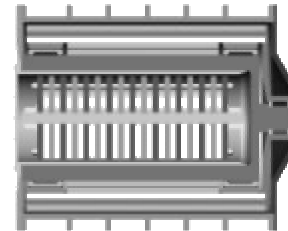
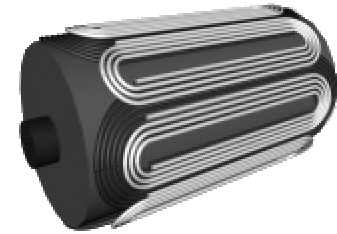
Pulsed Power Research Program **ARL**

The Pulsed Power research effort is focusing on the following critical tasks:



Synchronization and control of pulsed alternator pairs.

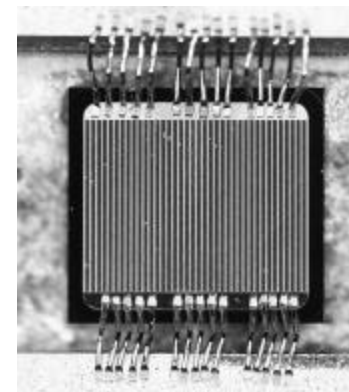
Analysis and simulation of pulsed alternator topologies (disk, drum, cup, ...).



Alternative (Non-rotating) pulsed power systems.

Advanced switching concepts:

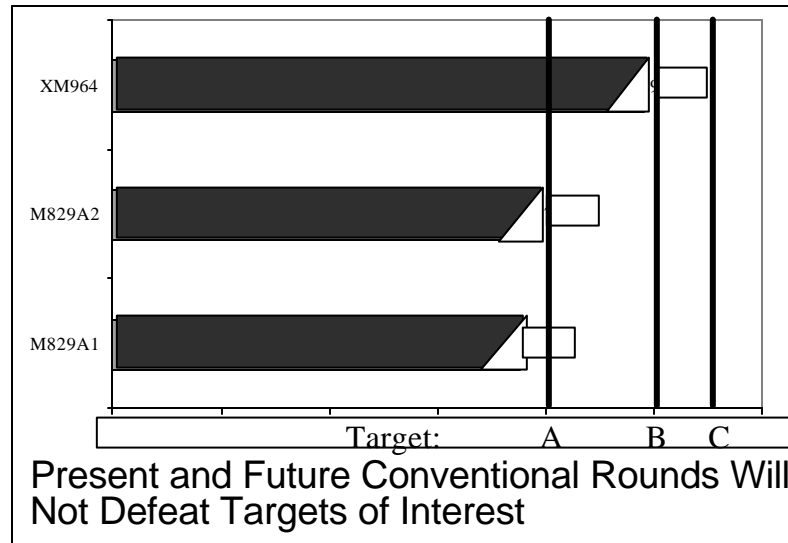
- Silicon Carbide
- Optical Triggering
- Opening Switches



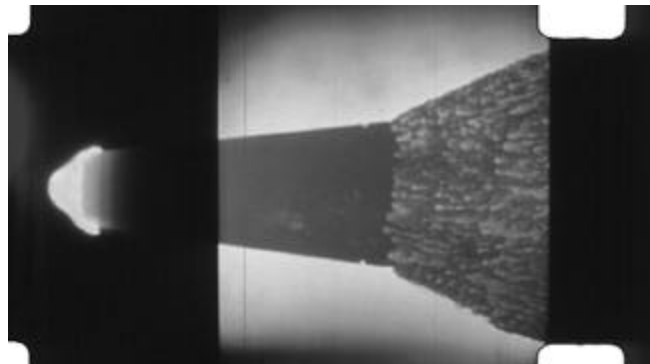
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Hypervelocity Lethality Accomplishments



IAT Novel Kinetic Energy Penetrator (NKEP) Defeated Target at Low Impact Energy



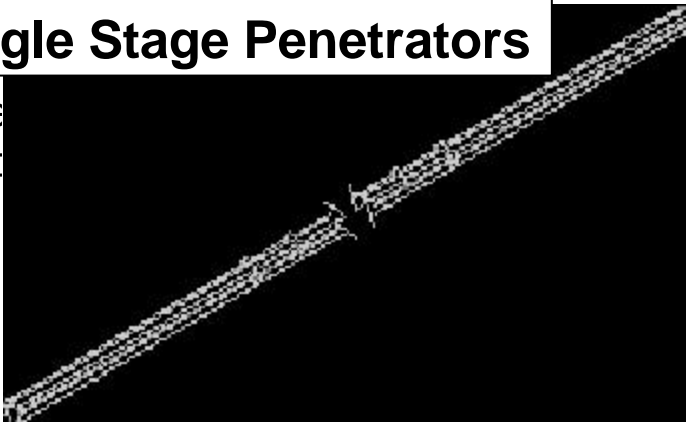
IAT has Developed Analytic and Experimental Methodology to Solve Ablation Problem

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Hypervelocity Lethality Plans **ARL**

Single Stage Penetrators

Ne
Inc

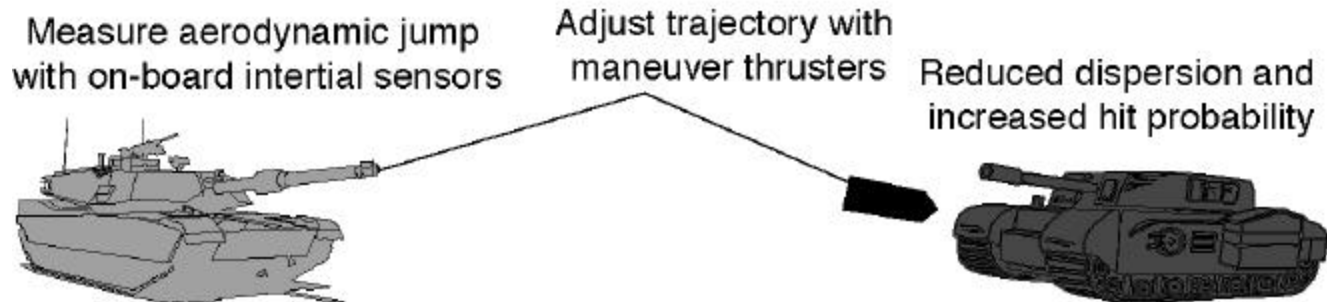


Extending Penetrators



New geometries and optimization studies.

Guidance & Control



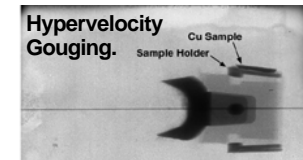
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Progress with Hypervelocity Launch



- **Hypervelocity Gouging:** A major show stopper identified in 1995 has been resolved.

- We now have a scientific understanding of the phenomenon and predictive capability.
- Robust engineering solutions involve use of hard cladding.
- Gouge-free railgun operation demonstrated to 2.85 km/s.



Muzzle radiograph from experiments to measure gouging threshold velocities of various materials.

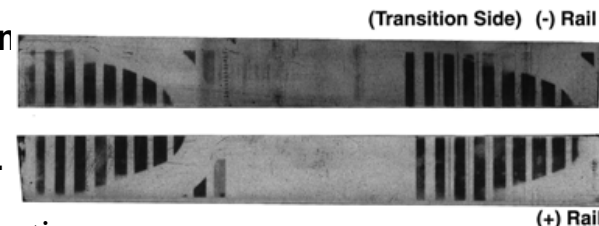
- **Muzzle Signature Suppression** can be performed effectively using an Inductive Muzzle Shunt.

- Three generations of shunts tested at IAT.
- EM Spectral measurements demonstrated the possibility of operation EML in ultra-low signature mode.
- Significantly less EM than conventional guns.
- Current research at IAT
 - Use of Inductive Shunt to recover energy from EML
 - Shunt armature interaction to stabilize armature.



- **Transition to Arcing Contact** is a difficult problem is within reach (~2years).

- We understand the phenomenon (multiple cause identified) Modeling capabilities being developed.
- Actively exploring design solution.



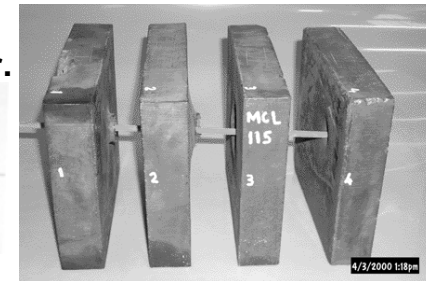
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Progress with Hypervelocity Launch



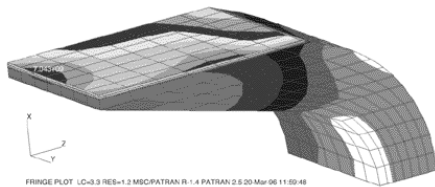
- Integrated Launch Package Development
 - Tungsten Rods successfully launched from our EM launcher.



- Thermal Structural Modeling

- EMAP3D

- (1995) Only program to solve Coupled EM-Thermal diffusion w/sliding electrical contact.
- (1997) One way coupling to DYNA3D allows large deformation thermo elastic plastic.
- 1999 -2001 Parallelization of EMAP3D on Beowolf PC Cluster made it a comprehensive design and detail analysis tool.
- 2001 Plasticity Module expand EMAP3D application further.

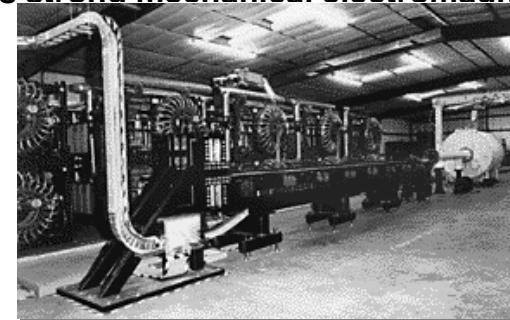


- Hybrid BE PE Formulation facilitates strong mechanical electromagnetic coupling,

- Experimental Facilities

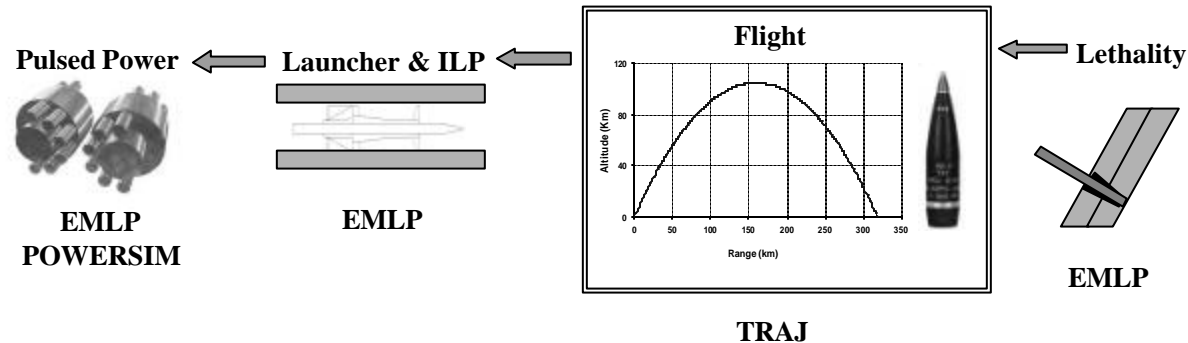
- Largest operational EM research facility, 13MJ Power Supply
- Over 250 test supporting EML research
- Upgrade planned for 2001 with double the muzzle energy and add two new launcher

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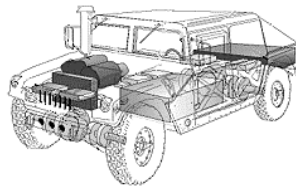


Systems & Technology Integration

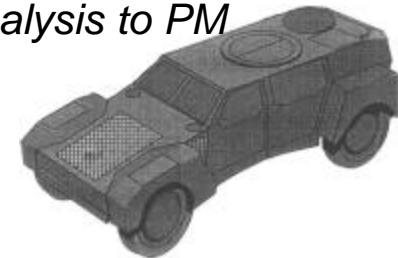
EM Gun System Performance Analysis – Software Development



Vehicle Performance – POWERSIM Model validated with Hybrid Electric HMMWV tests *



- ### DARPA Support*
- **CHPS** - IMPACT Toolbox completed & made available to government and industry
 - **RSTV** - Provided modeling and technical analysis to PM





Army EM Gun Program



- Program Management
- Technical Support



- Basic 6.1 Research
- Integral Member of ARL Program Office/Team



- Technology Development
- Technology Component Development
- Technology Integration



Summary



- **Major Leap Ahead Technology for the Future**
- **Offers Enhanced Lethality & Survivability for Future Combat Systems**
- **Technology is sufficiently mature to move forward with a demonstration program**
- **May not meet timeline for FUE but should be a key technology for Block I upgrade**

